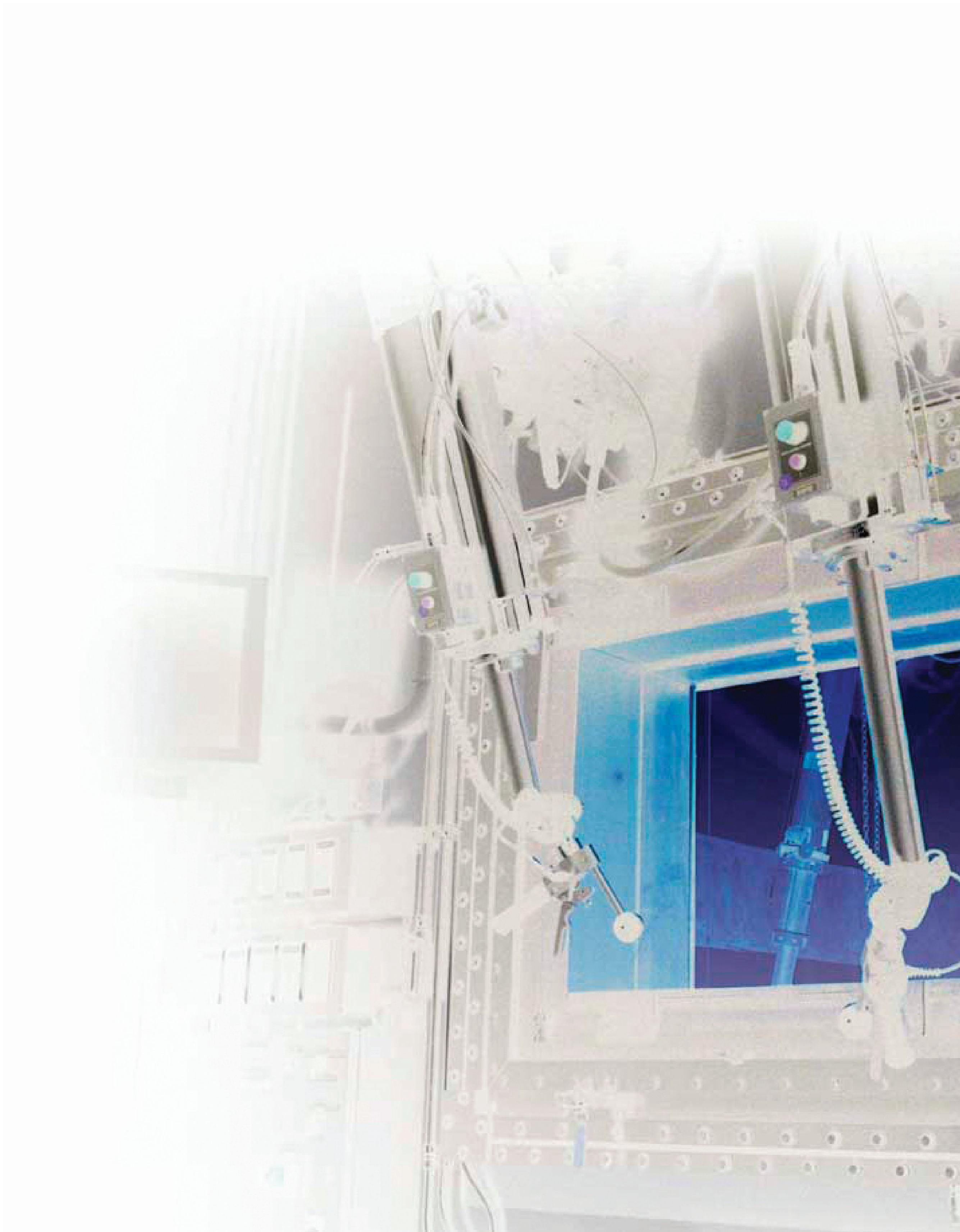
special projects



Special Projects

Completion of the LANSCE Switchyard Kicker Project

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In the late 1990s, planning began on a project to upgrade the LANSCE beam switchyard to allow simultaneous, uninterrupted beam delivery to the Lujan Center and the Weapons Neutron Research (WNR) facility through Line D, and the Proton Radiography (pRad) and Ultracold Neutron (UCN) research areas through Line X. The project, dubbed the "Switchyard Kicker", received funding in July 2001 for design and implementation. During the calendar year (CY) 2003 outage, this upgrade was installed in the switchyard and commissioned during the accelerator turn-on period in the summer of 2003. With the commissioning successful, LANSCE now routinely operates in "kick" mode, delivering simultaneous beam to Line X and Line D, increasing beam availability to all areas and simplifying production scheduling.

Until this year, the existing configuration of the switchyard did not allow simultaneous delivery of the H^- beam to lines D and X. In the late 1990s, with increased activities in areas B and C, which serve UCN and pRad, respectively, planning began to increase beam availability to all areas by installing a "kicker" system. The term "kicker" refers to a magnet or system of magnets that can be pulsed on and off in the space of a few milliseconds, so that individual beam pulses can be directed to different beam lines.

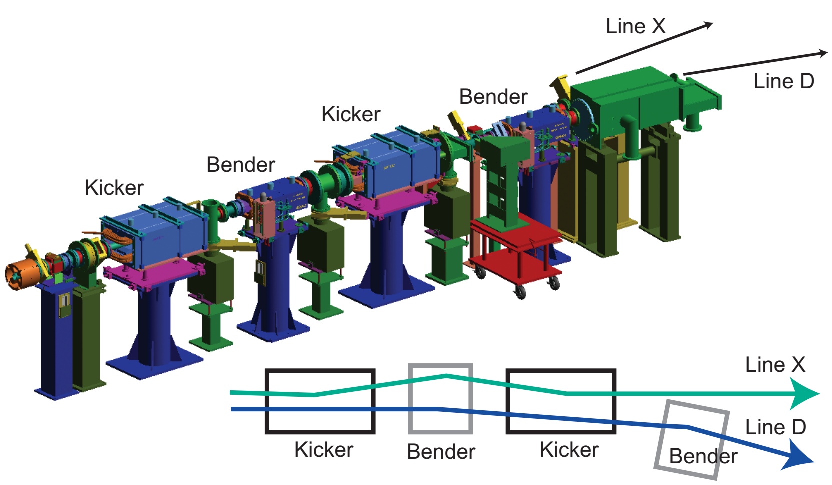

Figure 1. Solid-model rendering of the kicker system as built, which includes two pulsed magnets, two direct-current bender magnets, beam-position monitors and other beam diagnostics, a revised vacuum system, and controls enhancements. Below, a schematic shows the bend directions for Line D beam (in purple) and Line X beam (in blue).

The Switchyard Kicker is actually a system of pulsed and direct-current (DC) magnets, shown in Figure 1, that enables simultaneous, uninterrupted beam delivery to Line D and, on request, a tailored H^- beam pulse to Line X. For beam delivery to the Lujan Center and WNR, the c-magnets deflect the beam into Line D. When fired, the two kicker magnets counteract the bend of the first c-magnet, sending the beam straight ahead into Line X (Figure 1).

The design focused on risk reduction and cost efficiency. The kicker magnets were nearly exact copies of an existing unit that has proven to be highly reliable in the Proton Storage Ring (PSR) injection line. The modulators were updated versions of the PSR injection-line modulator and were fabricated in-house. An existing DC power supply was upgraded for use with one of the c-magnets. The project also had both technical and cost-savings benefits in adapting an existing Isotope Production Facility design for the beam-position monitors (BPMs). The design for the c-magnets is similar to that for magnets in wide use at LANSCE, and the field quality is sufficient to preserve the beam quality required for PSR injection.

All the main components were procured or fabricated by late 2002. The beam-line components were staged in December 2002. Installation began in late January 2003, when accelerator operations ceased and the CY 2003 extended maintenance period began. The section of switchyard beam line to be upgraded was removed (see Figure 2, top and middle). Alignment surveys of adjacent components were conducted to determine proper magnet and magnet-stand placement. The stands, magnets, vacuum components, and diagnostics were then installed and aligned (Figure 3). The beam-line installation included the two new DC magnets, the two new kicker magnets, three new BPMs, a new wire scanner, new activation protection devices, and rearrangement of some of the existing wire scanners and current monitors. At this time, the power supplies, electronics, and controls were also being completed in the equipment aisle above the switchyard.

Commissioning activities began in June 2003 during the restart of the accelerator complex for the 2003 run cycle. The LANSCE Switchyard

Figure 2. The switchyard before the upgrade (top), after the old equipment had been removed (middle), and after the upgrade was complete (bottom).

Kicker System achieved a milestone on July 10, 2003, by simultaneously delivering the first inter-leaved beam pulses to the PSR (for the Lujan Center), the WNR facility, and Line X (for pRad).

The kicker system is capable of continuously delivering full-beam macropulses at a repetition rate of 1 to 30 Hz to Line X. The system has the capability of delivering a single macropulse on request with a micropulse structure tailored to the experimenter's requirements, and it preserves the capability to operate in all the other existing modes. In particular, operation does not impact H^- beam delivery to Line D, other than increasing beam availability to the Lujan Center and WNR programs. The kicker system eliminates the need to retune the accelerator to accommodate varying beam intensities and time structures. This stable-accelerator operation at fixed-beam intensity yields more reliable beam delivery for all programs and reduces time and resources needed for beam retuning.

This achievement represents a significant enhancement in the ability of LANSCE to fulfill its commitments to both the National Nuclear Security Administration (NNSA) and the Department of Energy Office of Science.

Figure 3. (a) Work proceeds on installation of the kicker magnets. (b) Project members adjust one of the bender magnets. (c) Final assembly of vacuum components nears completion.

Completion of the New Isotope Production Facility

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LANSCE has supported the Los Alamos Radioisotope Program for more than 20 years by irradiating target materials whenever appropriate accelerator beam was available. That support has been critical to the long-term success of this important and highly visible Department of Energy (DOE) program. However, the cessation of activities in Experimental Area A after 1998 made it necessary to implement a new irradiation capability for this support to be continued. The Isotope Production Facility (IPF) project was undertaken to fulfill this need. The Conceptual Design Report was written in 1997, capital funding was received in 1999, and the project was completed in the fall of 2003 for a total cost of $23M.

LANL Laboratory Director Pete Nanos joined facility sponsor William D. Magwood IV, chief of DOE's Office of Nuclear Energy, Science and Technology; Senator Jeff Bingaman; and New Mexico Governor Bill Richardson in a ceremony on January 12, 2004, to dedicate the new facility. Speaking before 150 invited guests, Mr. Magwood applauded the Laboratory's success in completing the first dedicated isotope facility in more than 20 years and completing the more than 50,000 hours of construction on the facility without a single lost work day.

The facility houses a new beam line and equipment (Figure 1 shows the hot-cell manipulators, part of IPF's new equipment) needed to direct part of the proton beam from the existing LANSCE accelerator to a new target station designed specifically for the production of radioisotopes. The IPF utilizes a portion of the H^+ accelerator beam extracted at 100 MeV and operates without influencing scheduled beam delivery of H^- beam to other experimental areas at LANSCE.

The first accelerator beam was delivered to the IPF at 11:34 p.m. on December 23, 2003. Since that time, commissioning efforts have focused on improving the reliability of the beam, and sustained beam deliveries in excess of 100 μA have been achieved. During the spring of 2004, commissioning activities continued with irradiations of increasingly complex target assemblies at progressively higher beam intensities until high-power irradiations of

Figure 1. Chemistry Division employee Louie Salazar operates the hot-cell manipulators at the new IPF at LANSCE.

representative production target assemblies are demonstrated. We expect to complete the commissioning activities during the 2004 LANSCE operating cycle so that the 2005 cycle will begin with the IPF facility fully operational.

The new facility will allow production of a wide range of radioisotopes to support medical diagnosis and treatment and scientific research. A few of the key isotopes to be produced include strontium-82, germanium-68, copper-67, and silicon-32. Table 1 lists the radioisotopes that will be initially produced at the IPF.

Strontium-82 is supplied to Amersham Health for use in the CardioGen® rubidium-82 generator. The generators in turn are supplied to hospitals and medical laboratories to support cardiac imaging through positron emission tomography (PET). The generator technology was developed by the DOE Medical Radioisotope Program during the 1970s and 1980s, and the technology transferred to private industry in the late 1980s.

Table 1. Radiosotopes for Initial Production at the IPF.

Isotope	Half-Life	Target Material	Energy (MeV)	Expected Yield (μCi/μAh)
Sr-82	25.5 d	RbC1	90-70 65-45	130 230
Ge-68	270 d	Ga	30-10	32
Cu-67	2.6 d	Zn	65-45	115
Re-186	3.2 d	W-186	30-10	50
V-48	16 d	Cr	90-70	1100
As-73	80.3 d	Ge	30-10	171
Zr-88	83.4 d	Nb	90-70	235
Na-22	2.7 y	Mg	65-45	24
Si-32	~ 100 y	NaC1	90-70	0.0003

The DOE continues to be one of the principal suppliers of the strontium-82 for the generators. Strontium-82 is produced by bombarding rubidium chloride or rubidium metal with protons with energies between 40 and 70 MeV.

Germanium-68 is used for calibration sources for medical imaging equipment. Hospitals and research institutions across the nation use such sources everyday to calibrate PET scanners. Without such calibrations, the usefulness of equipment for medical imaging and research would be severely limited. Germanium-68 is produced by bombarding gallium metal with protons with energies between 20 and 70 MeV.

Copper-67 is used in cancer research and treatment. It has radiations that are useful for both imaging and treatment. This, combined with its rich chemistry, makes it especially useful for research applications in which the radioactive copper is chemically attached to antibodies that are attracted to cancerous cells. In this way the radioactivity can be localized in tumorous tissues, allowing one to both image the tumor and also to deliver high radiation doses to the tumor while minimizing undesirable side effects. In the past this research has been limited by the availability of copper-67. The new IPF promises to greatly improve that availability. Copper-67 is produced by bombarding zinc or zinc oxide with protons with energies between 40 and 90 MeV.

Silicon-32 is used in oceanographic research to study the silicon cycle in marine organisms, principally diatoms. Its use in this application has dramatically improved the timeliness and quality of data available in this area of environmental research. Silicon-32 is produced by high-energy (> 90 MeV) proton bombardment of sodium chloride.

With the completion of the IPF at LANSCE, LANL will continue its tradition of producing and distributing a rich variety of radioisotopes for medical, industrial, environmental, and other tracer applications.